A Dyadic Approach for Measuring and Testing Agreement in Interpersonal Perception

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ABSTRACT

The present research deals with developing a new index to measure interpersonal perception agreement at group level. This index is decomposed into components to obtain dyadic and individual effects. Unlike other indexes and statistical methods founded on correlation coefficients to quantify interpersonal perception relationships and agreement, the procedure proposed is based on interpersonal perceptions discrepancies among individuals. Specifically, this study deals with interpersonal perception measurements obtained by means of *p*-point rating scales where *p* is the number of response options, for instance, *Likert* response scales. Apart from descriptive statistical analysis, the procedure enables to obtain statistical significance by means of Monte Carlo sampling. The statistical method proposed can be useful for social researchers interested in studying group and teams, as this procedure allows them to quantify interpersonal perception agreement at several levels, to obtain statistical significance, and to use these measures as new characteristics for understanding social processes.

Author Keywords

Interpersonal perception agreement; dyadic analysis; group and team processes.

INTRODUCTION

Social interaction investigations have been often founded on individualistic research methods. That is, social researchers commonly measure people one at a time and then apply statistical methods that assume people's actions, beliefs, thoughts, feelings, and perceptions are independent of the others. Nevertheless, it has been pointed out that a psychology of interpersonal relations should take into account the perceptual underpinnings since people's actions towards others are shaped by their perceptions of them [4, 5]. Additionally, individualistic research methods are not suitable for finding patterns of mutual influence and interdependence [1]. Hence, the main drawback of the individualistic approach is ignoring that social phenomena involve more than one person and that is why dyadic methods have been increasingly developed and proposed to analyze social data.

The Social Relations Model [SRM; 6] has been proposed to study interpersonal perception as a two-sided process since each group member assesses the others. Data are decomposed into four components (constant, actor, partner, and relationship effects) and dyadic and generalized reciprocity are estimated. Dyadic reciprocity in interpersonal perception refers to how all pairs of individuals in dyads perceive each other, while generalized reciprocity corresponds to how individuals are perceived by the others and how each individual perceives the others. It should be noted that dyadic and generalized reciprocity, respectively, correspond to dyadic and individual levels of analysis. In the SRM, correlation values are obtained to quantify dyadic and generalized reciprocity in interpersonal perception. The SRM undoubtedly shows psychologists' interest for measuring agreement, although there are other illustrative examples in psychological literature. For instance, a coefficient of judges' agreement for unordered scales has been proposed to measure to which extent nonchance factors are operating in the direction of agreement [2]. More recently, an index has been developed to assess the degree of interrater agreement for ratings of a single item and multi-item scales [3].

According to Kenny [5], dyadic and generalized reciprocity in interpersonal perception are defined and consequently measured as correlations among people's responses. Nevertheless, agreement in interpersonal perception could also be measured as the discrepancy between individuals' interpersonal perceptions, not only as correlation coefficient values. Interestingly, if such a discrepancy measure were developed, social researchers would have two procedures to

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study interpersonal perception. Both measures would enable them to obtain different information about interpersonal perception processes.

The present study is concerned with research designs in which observations have been made on all dyads of a group. Particularly, this work deals with interpersonal perception measurements obtained by means of *p*-point rating scales where *p* is the number of response options, for instance, a *Likert* response scale from 1 to 6. The research was specifically intended to provide a new statistic, based on dyadic discrepancies between rates assigned mutually by individuals, for measuring agreement in interpersonal perception at global level. Additionally, the statistic should be decomposed into parts to estimate dyadic and individual effects, and exact analytical results for the expected value and standard error should be also derived in order to make proper comparisons between theoretical and empirical values. Moreover, as statistics' exact distribution has not been derived yet, a statistical test founded on Monte Carlo sampling is proposed.

MEASURING AGREEMENT IN INTERPERSONAL PERCEPTION

The statistic proposed for measuring agreement in interpersonal perception is as follows:

$$\eta = \frac{2\sum_{i=1}^{n}\sum_{j=i+1}^{n}\left(x_{ij}-x_{ji}\right)^2}{n\left(n-1\right)\left(p-1\right)^2}, \quad n \geq 2, p \geq 2,$$

where x_{ij}, n, and p respectively denote how individual i perceives individual j, group size, and the maximum value for *Likert* scales. This statistic ranges from 0 to 1. If η equals 0, it means that all individuals give others the same score they receive from them, that is, there is agreement in interpersonal perception. On the other hand, the maximum value of discrepancy among participants corresponds to η = 1. In order to decompose dyadic effects, note that

$$\eta = \frac{\sum_{i=1}^{n}\sum_{j=i+1}^{n}2\left(x_{ij}-x_{ji}\right)^2}{n\left(n-1\right)\left(p-1\right)^2} = \sum_{i=1}^{n}\sum_{j=i+1}^{n}\eta_{ij}$$

where η_{ij} denotes dyads' contributions to overall interpersonal perception disagreement, being $\eta_{ij} = \eta_{ji}$. Similarly, individual effects can also be decomposed as follows:

$$\eta = \frac{\sum_{i=1}^{n}\sum_{\substack{j=1\\ j\neq i}}^{n}\left(x_{ij}-x_{ji}\right)^2}{n\left(n-1\right)\left(p-1\right)^2} = \sum_{i=1}^{n}\left(\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\left(x_{ij}-x_{ji}\right)^2}{n\left(n-1\right)\left(p-1\right)^2}\right) = \sum_{i=1}^{n}\eta_i$$

where η_i denotes individuals' contributions.

EXPECTED VALUES

In order to obtain expected values and statistical significance is needed to suppose a probability distribution for individuals' ratings. Discrete uniform distribution is here proposed as it corresponds to the lack of preference. Thus, it can be proved the expected values for the global index are:

$$E\left[\eta\right] = \frac{p+1}{6\left(p-1\right)}$$

$$SE\left[\eta\right] = \sqrt{\frac{7p^4-20p^2+13}{90n\left(n-1\right)\left(p-1\right)^4}}$$

These expected values allow researchers to carry out proper compassion since the bias and variability of the statistic are known.

STATISTICAL INFERENCE

For statistical testing of agreement in interpersonal perception at group level, the null hypothesis states that each group member randomly assigns ordered values to the others. It has been often assumed in related statistical techniques that random variables x_{ij} follow a discrete uniform distribution. Nevertheless, there is no theoretical proof to discard other discrete mass probability functions for modeling group members' responses (e.g., triangular and U-shaped distributions). Hence, exact sampling distribution depends on mass probability functions, group size, and the range of the *Likert* scale. Table 1, whose values have been analytically obtained, shows the exact sampling distribution of the global statistic for n = 3 and p = 4, assuming a discrete uniform distribution.

For practical purposes, obtaining the exact distribution for the statistic has no sense since it depends on the mass probability function that random variables x_{ij} follow. For this reason, a more useful statistical method is required. Monte Carlo methods are a way of solving the problem and estimating probabilities, that is, *p* values. We have developed software with R language, which is delivered upon request, for testing agreement in interpersonal perception. Monte Carlo sampling allows researchers to obtain statistical significance for each index, that is, at group, dyadic, and individual levels. It is only required to specify group size, maximum values for *Likert* scale, and mass probability functions for each x_{ij}. Finally, users are also required to establish the number of simulated groups or, if preferred, samples.

Statistic value	*p*-value
1.0000	.001953
.8148	.013672
.7037	.031250
.6667	.042969
.6296	.066406
.5185	.136718
.4815	.183593
.4444	.199218
.4074	.251952
.3704	.322264
.3333	.416014
.2963	.462889
.2222	.568358
.1852	.708983
.1481	.755858
.1111	.808592
.0741	.914061
.0370	.984373
.0000	1.000000

Table 1. *p*-values associated to global agreement statistic values.

EXAMPLE

Suppose a group of n = 3 individuals has been formed to develop a new product. After the task the participants were asked to score each other, by a rating scale from 1 to 4 (i.e., p = 4) in the following question: 'She/He profited the time available to solve the task.' The following matrix shows the fictitious data:

$$\mathbf{X} = \begin{pmatrix} 0 & 4 & 4 \\ 1 & 0 & 2 \\ 1 & 2 & 0 \end{pmatrix}$$

The global statistic can be computed as follows:

$$\eta = \frac{2(9+9+0)}{54} \simeq .6667$$

As the mathematical expectancy for the global index equals .2778, the value obtained clearly exceeds it. Furthermore, the exact *p*-value associated to the statistic is approximately equal to .0117. These results suggest that group members' interpersonal perceptions agree less than expected by chance.

Dyadic contributions to interpersonal perception disagreement are $\eta_{12} = 1/3$, $\eta_{13} = 1/3$, and $\eta_{23} = 0$. Hence, dyads that rate each other more dissimilarly are 1-2 and 1-3. As regards individual' effects, $\eta_1 = 1/3$, $\eta_2 = 1/6$, and $\eta_3 = 1/6$. The individual who shows the highest discrepancy between directed and received scores is denoted by *1*.

CONCLUSIONS

We have developed a statistical method that enables social researchers to obtain interpersonal perception agreement measurements at global, dyadic, and individual levels in groups. This statistical method allows social researchers to carry out descriptive and inferential statistical analyses and therefore they can quantify and make decisions concerning agreement in interpersonal perception. Statistical decisions can be taken for all levels of analysis, that is, global, dyadic, and individual levels. An R package has been written to make feasible obtaining statistical significance for all statistics.

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